DVEML 0227

INSTRUCTION MANUAL

MODEL 76A-01

IEEE 488-1975 BUS INTERFACE OPTION

FOR THE

MODEL 76A AUTOMATIC CAPACITANCE BRIDGE

76A-01

480

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SECTION I

INTRODUCTION

1.1 SCOPE OF MANUAL

1.2 This handbook provides descriptive data and operating instructions for the Model 76A-01 IEEE 488-1975 Bus Interface option. The parts list for this option is found in the 76A Instruction Manual. The 76A-01 is manufactured by Boonton Electronics Corporation, Parsippany, New Jersey.

1.3 PURPOSE AND USE OF EQUIPMENT

1.4 The Model 76A-01 is a microprocessor controlled interface adapter which generates control signals for and reads panel meter data from the 76A circuits and generates IEEE 488 Bus compatible signals.

1.5 PERFORMANCE SPECIFICATIONS

1.6 Pertinent performance specifications of the Model 76A-01 are listed in Table 1-1.

TABLE 1-1

Interface Function:	SH1, AH1, T7, L3, SR0, RL1, PP0, DC1, DT1, C0
Address Selection:	5 position "dip" switch selects decimal address.
Bus Connector:	All data and bus management lines are compatible with IEEE 488-1975 specifications.
Power Requirements:	Internally powered from 76A mainframe.
Operating Temperature:	0 - 55°C

SECTION 1

INTRODUCTION

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SECTION II

OPERATION

2.1 GENERAL

2.2 This section contains instructions for the installation and operation of the Model 76A-01. It is recommended that the instrument operator familiarize himself with the material in this section before attempting to operate the equipment; otherwise the full capability of the interface may not be realized in use.

2.3 INSTALLATION

NOTE: If the option is already installed in a new 76A, proceed to Paragraph 2.6.

2.4 UNPACKING. The Model 76A-01 is shipped complete and ready for installation upon receipt. Unpack the interface assembly and processor board from the shipping container and inspect them for damage that may have occurred during shipment. Check that all IC's are seated in their sockets and that the address switch operates properly.

NOTE: Save the packing material and container for possible use in reshipment of the equipment.

TABLE 2-1. ASSEMBLY PARTS LIST

Item	Description	Quantity
1	Printed Circuit Board (566395)	1
2	Connector Cover and small PC Board (566415), assembled with four screws and nuts	1

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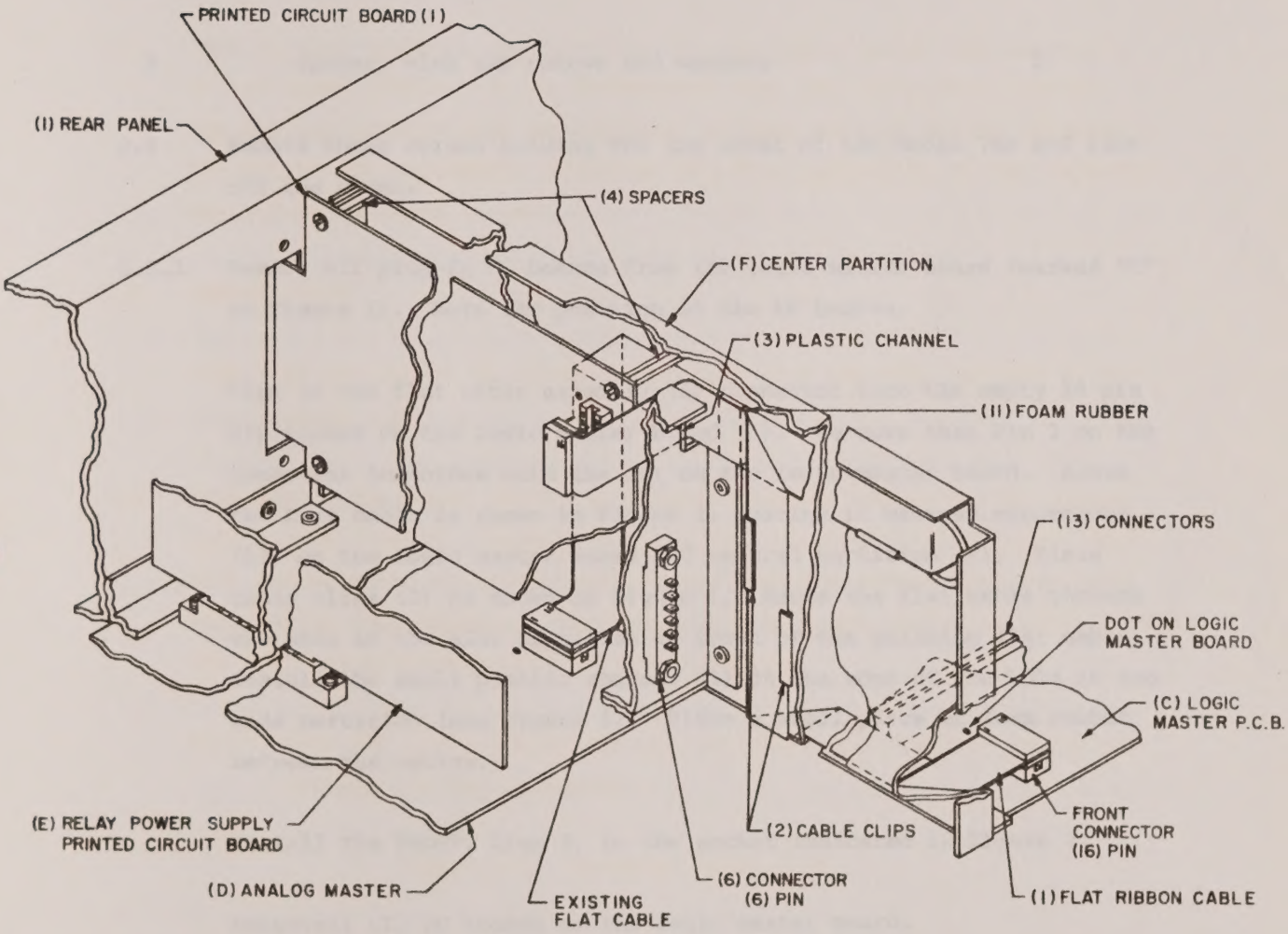


Figure 1. Installation of the Model 76A-01

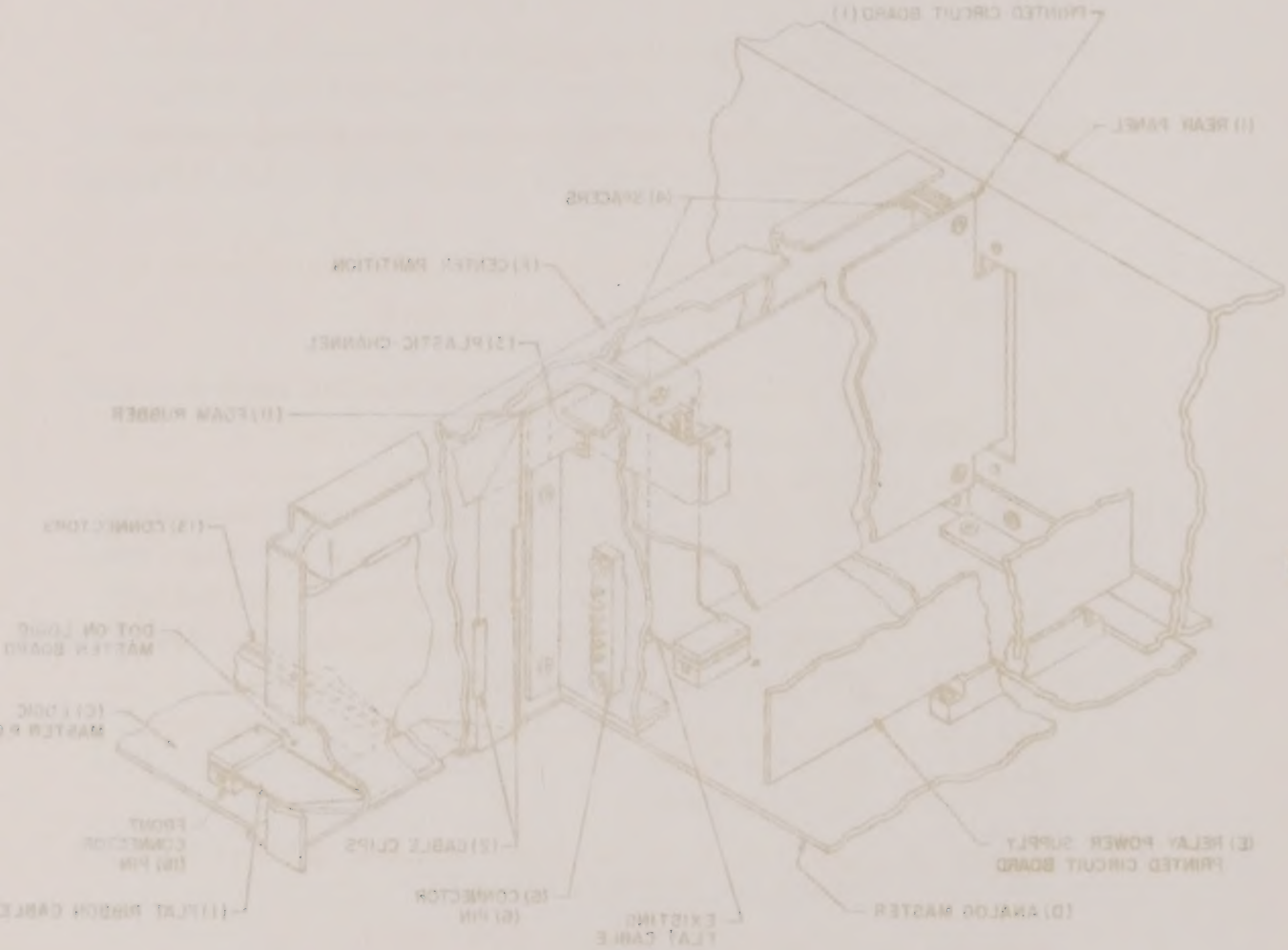


Figure 1. Installation of the Model 764-01

TABLE 2-1. ASSEMBLY PARTS LIST (Continued)

Item	Description	Quantity
3	3M Flat Cable Assembly	1
4	PROM 2716 marked	1
5	Spacer, with two screws and washers	2

2.5 Remove three screws holding the top cover of the Model 76A and lift off the cover.

2.5.1 Remove all plug-in PC boards from the logic master board (marked "C" on Figure 1). Note the position of the PC boards.

Plug in the flat cable assembly (1) connector into the empty 16 pin dip socket on the logic master board (C). Be sure that Pin 1 on the connector coincides with the dot on the logic master board. Route the flat cable as shown in Figure 1, spacing it between connectors (13) on the logic master board and central partition (F). Place cable clips (2) as shown in Figure 1. Route the flat cable through the hole in the side partition in front of the existing flat cable. Install the small plastic channel (3) on the edge of the hole in the side partition (see Figure 1). Place a small piece of foam rubber between the cables.

Install the PROM*, Item 4, in the socket indicated in Figure 2.

Reinstall all PC boards on the logic master board.

2.5.2 Install both spacers (4) at the holes in the center partition (F).

2.5.3 Temporarily remove the relay power supply PC board (E).

**WARNING:* *To prevent damage to the PROM during installation, protect against the buildup of static voltages.*

2.5.4 Insert the printed circuit board, Item 1, diagonally, so that the larger row of fingers will go through the oblong hole in the rear panel. Put the board far enough into the hole to permit the opposite end to plug into the 6 pin connector (6) on the partition.

NOTE: Components on the board should face away from the partition (F).

Attach the board to the spacers (4), but do not tighten.

2.5.5 Plug the flat cable connector into the DIP connector on the board. Pin 1 on the connector must coincide with the dot on the board.

2.5.6 Reinstall the relay power supply board (E) that was removed earlier.

2.5.7 Remove the four nuts which hold the cover and small PC board together, Item 2. Note the location of the long and the short screws. (The nuts can be discarded.)

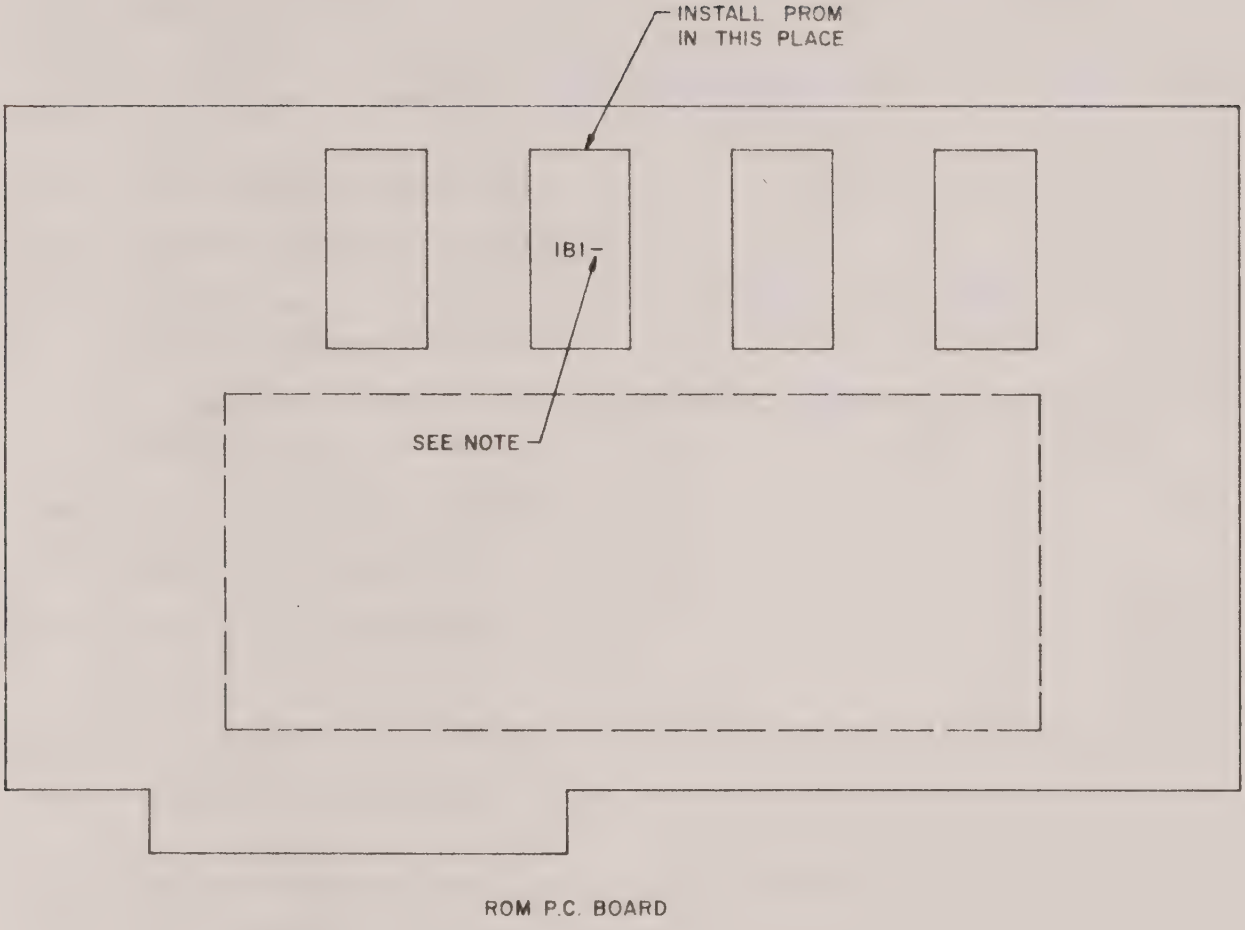
2.5.8 Fit the small PC board on the outside rear of the 76A. It plugs onto the protruding fingers of the main PC board just installed.

2.5.9 Install the cover of the small PC board with the screws supplied.

NOTE: Before tightening the four screws to the cover, tighten the two spacer screws at (4).

2.5.10 Replace the top cover on the instrument.

2.6 CABLE CONNECTIONS. The only cable connection required is the IEEE 488 Bus Interface cable supplied with each 76A-01.



NOTE:
1. DASH INDICATES AREA OCCUPIED BY ISSUE NUMBER FOR PROM

Figure 2. ROM PC Board

2.7 OPERATION. The Model 76A Capacitance Bridge may be remotely controlled via the IEEE Std. 488-1975 Digital Interface Compatible Instrumentation. The capability of the 76A when connected to the Interface Bus is specified in Table 2-2.

TABLE 2-2. INTERFACE FUNCTIONS

SH1	Source handshape capability
AH1	Acceptor handshake capability
T7	Talker (basic talker, no serial poll talk only mode, unaddressed to talk if addressed to listen)
L3	Listener (basic listener, listen only mode, unaddressed to listen when addressed to talk)
SR0	No service request capability
RL1	Remote/Local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT1	Device trigger capability
C0	No controller capability

2.8 ADDRESS SELECTION. The talk and listen addresses of the 76A are selected by the address selector switch (Figure 3) located on the rear panel. This switch is a five position "DIP" switch with positions marked "1" through "5" as the address code. Table 2-3 lists the available address codes and the corresponding switch settings.

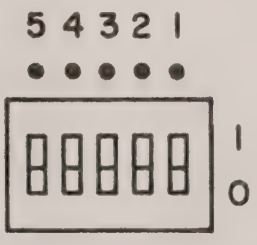


Figure 3. Address Selector Switch

TABLE 2-3. Address Selection

ASCII Code Character							
Listen	Talk	A5	A4	A3	A2	A1	5-Bit Decimal Code
SP	@	0	0	0	0	0	00
!	A	0	0	0	0	1	01
"	B	0	0	0	1	0	02
#	C	0	0	0	1	1	03
$	D	0	0	1	0	0	04
%	E	0	0	1	0	1	05
&	F	0	0	1	1	0	06
'	G	0	0	1	1	1	07
(	H	0	1	0	0	0	08
)	I	0	1	0	0	1	09
*	J	0	1	0	1	9	10
+	K	0	1	0	1	1	11
,	L	0	1	1	0	0	12
-	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
Ø	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	1	1	0	1	0	26
;	[	1	1	0	1	1	27
<	\	1	1	1	0	0	28
=	]	1	1	1	0	1	29
>	≈	1	1	1	1	0	30

76A-01

2.9 PROGRAM CODES. All front panel controls except the power switches and zero controls are programmable via the Interface Bus. The program codes for each switch are listed in Table 2-4.

TABLE 2-4. Program Codes

Capacitance Range

C0	Autorange
C1	2 pF range
C2	20 pF range
C3	200 pF range
C4	2000 pF range

Conductance Range

G0	Autorange
G1	2 µS range
G2	20 µS range
G3	200 µS range
G4	2000 µS range

Series/Parallel Mode

S0	Parallel
S1	Series

Differential Capacitance Modes

D0	Absolute capacitance
D1	Differential capacitance, pF
D2	Differential capacitance, percent

TABLE 2-4. Program Codes (Continued)

Loss Readout Modes

L0	Conductance
L1	Resistance; R_s ohms, R_p Kilohms
L2	Dissipation
L3	Q

Zero Correction Modes

Z0	Manual zero
Z1	Corrected zero mode*

Terminal Modes

X0	Panel terminals
X1	Remote fixture terminals

Bias Voltage Programming

Bn	n = voltage, positive value only

Nominal Capacitance, Different Capacitance

Nn	n = nominal value, pF; positive only

*This command will initiate a zero residue measurement cycle. The terminals should be at "zero" test condition, and the panel zero controls should have set the instrument to near-zero condition.

TABLE 2-4. Program Codes (Continued)

Reset Program Status to Initial Conditions

R	Reset programming
	Sets up the following programming:
	Capacitance autorange
	Conductance autorange
	Parallel capacitance readout (C_p)
	Conductance readout (G)
	Manual zero
	Panel test point
	Zero volts bias

Trigger Start of Measurement

T	Trigger measurements

2.10 PROGRAMMING. The 76A is programmed by data messages sent by the system controller. These messages are composed of the address command and the program information. The address command consists of the talk address of the controller and the listen address of the 76A. The program information consists of the codes of the 76A controls to be programmed. Syntax for the address command is a function of the system controller, and for the 76A according to the codes listed in Table 2-4. Table 2-5 gives the 9815 controller codes.

TABLE 2-5. 9815 Controller Codes

Keystroke	Printout	
CALL ALPHA 5 (E)	DVPGM	5
CALL ALPHA 5 (D)	STR→α	5
CALL ALPHA 5 (J)	LDPGM	5
CALL ALPHA 5 (I)	α→STR	5

TABLE 2-5. 9815 Controller Codes (Continued)

Keystroke	Printout
CALL ALPHA 5 (O)	STAT 5
CALL ALPHA 5 (L)	FIELD 5
CALL ALPHA 5 (K)	SERPL 5
CALL ALPHA 5 (A)	OUTPUT 5
CALL ALPHA 5 (B)	WBYTE 5
CALL ALPHA 5 (C)	WRT X
CALL ALPHA 5 (F)	INPUT 5
CALL ALPHA 5 (G)	RBYTE 5
CALL ALPHA 5 (H)	READ X

Following are examples using a 9815 calculator as controller:

Example No. 1. The user intends to use 76A panel terminals to measure a certain specimen's capacitance and conductance with 1 V bias when triggered. Capacitance measurement is in the Parallel mode, Autorange, Absolute value. Loss measurement is in Autorange, Conductance readout. Instrument zero will be done manually.

Assume the instrument address is 10010 (binary) or 18 (decimal). The REMOTE ENABLE message should be sent at this time:

CALL ALPHA, 5, CALL ALPHA, F^{-1}, B, CALL ALPHA

The external program annunciator on the front panel of the 76A should be illuminated.

The user may keystroke as follows:

1	
ENTER ↑	
18	
ENTER ↑	
CALL ALPHA	
5	
CALL ALPHA	
RUN/STOP	
Z0	manual zero
X0	panel test point
B1.0000E00	1 V bias
S0	parallel mode
C0	C autorange
D0	absolute C value
G0	G autorange
L0	G readout
T	trigger

After the trigger message is sent, the instrument assumes the unaddressed state. For subsequent triggers to be sent the user must address the 76A as shown above. The exception to this sequence is when the user keystrokes a program into the calculator memory, and a loop condition exists.

The programmer may find that the 9815 must be slowed to allow the 76A to respond to the trigger command. This may be accomplished by sending "A" prior to the "T".

Example No. 2. The user intends to use remote fixture terminals to do a serial mode measurement acquiring differential capacitance of a specimen with a nominal value of 68 pF. He also intends to read resistance of the capacitor. The specimen is under 150 V bias and the instrument zero is done

by machine automatically. The real panel address is 10001 (Binary) = 17 (Decimal).

The user may program as follows:

```
1
Enter ↑
17
Enter ↑
Call α
5
Call α
```

(The 76A is ready for command.)

```
Z1                      (Corrected zero mode)
X1                      (Remote fixture terminals)
S1                      (Serial mode)
B1.5000E02              (Bias voltage = 150 V)
C3                      ("C" is 200 pF range)
D1                      (Differential capacitance)
N6.8000E01              (Nominal value 68 pF)
L1                      (Loss readout mode = resistance)
```

Now the instrument is ready for trigger. The user should send command "T" for each measurement desired.

Example No. 3. This example is the continuation of the previous example. Suppose the user intends to set up the instrument in:

1) Capacitance autorange
2) Conductance autorange
3) Parallel capacitance readout
4) Conductance readout
5) Corrected zero mode
6) Remote test fixture
7) 123.45 V bias

Instead of reprogramming the instrument, the user may take advantage of the "R" command, which will achieve the first four setups. The program may be as follows:

R1	(Reset, the first four setups done)
Z1	(Corrected zero mode)
X1	(Remote test fixture)
N1.2345E02	(123.45 volt bias)
T	(Instrument triggered)

Example No. 4. Assume the same program format as Example No. 1. To program using the 9825, the user may keystroke as follows:

```
fmt 1,z;wrt718.1,"C0D0G0L0Z0X0B1.0000E00S0T"
```

If the 9825 must be slowed, sending "A" before the program sequence should be done.

2.11 DATA OUTPUT FORMATS

All numeric data sent from the 76A has the following format:

±n.nnnnE±nn ±n.nnnnE±nn

The numeric data sent out by the 76A in normal operation is that presented on the two panel digital readouts. The capacitance data is sent first, followed by the loss data. The controller should expect to read these two data blocks following the talk command. If the 76A is commanded to talk again without an intervening trigger command, it will retransmit the same data. If the programming mode is changed, the last measurement data will be recomputed as required to send the specified output quantities.

The user should note that the 76A has no CR/LF following the data string.

When using the 9815, delimiters must be entered into the data string in the calculator's memory, and the length of the data string must be defined to prevent the calculator from going into a memory overflow condition. The 9815 does not recognize a SPACE as a delimiter.

When using the 9825 to read data, fmt z must be used to suppress the CR/LF as the delimiter in the data string. The user need not add a delimiter between the data string to separate the capacitance and loss data, since the 9825 responds to a SPACE as a delimiter.

2.12 DATA ACQUISITION

Example No. 1 is a sample program used to acquire data from the 76A using the 9815 calculator. Under normal operating conditions the programming sequence followed by the trigger command precedes the data output sequence. In this example only the keystrokes required to output data to the printer are listed.

Example No. 1. The following sample program is used to read data from the 76A using the 9815.

```
0000 1
0001 6              0 to 2:  the instrument is addressed.
0002 ENTER ↑
0003 2
0004 4
0005 ENTER ↑
0006 1              3 to 9:  Data string length is identified and written into
0007 ENTER ↑                 registers of calculator's memory.
0008 0
0009 INPUT   5
0011 1
0012 2              11 to 19: After the twelfth byte a comma is inserted into
```

```
ØØ13 ENTER ↑        the data string as delimiter
ØØ14 Ø
ØØ15 +⇄-
ØØ16 ENTER ↑
ØØ17 4
ØØ18 4
ØØ19 WBYTE   5
ØØ21 2
ØØ22 4
ØØ23 ENTER ↑
ØØ24 Ø
ØØ25 +⇄-            21 to 29:  After Byte 24 a comma is written in as delimiter.
ØØ26 ENTER ↑
ØØ27 4
ØØ28 4
ØØ29 WBYTE   5
ØØ31 1
ØØ32 ENTER ↑
ØØ33 Ø
ØØ34 +⇄-            31 to 37:  Contents of register are read and displayed up
ØØ35 READX   5      to first delimiter (capacitance data).
ØØ37 PRINT
ØØ38 1
ØØ39 3
ØØ4Ø ENTER ↑        38 to 43:  Contents of register are read and displayed start-
ØØ41 Ø              ing with Byte  13 (relative to register zero) (loss data).
ØØ42 +⇄-
ØØ43 READX   5
ØØ45 PRINT
ØØ46 SPACE
ØØ47 SPACE
ØØ48 END
```

Example No. 2. Using the 9825 to acquire data from the 76A can be keystroked as follows:

```
fmt 2,z,2e12.4;red718.2,A,B
dsp A,B
```

This example is the data output from the program sequence used in Example No. 4 in Section 2.10.

Syntax requirements for the 9825 may differ slightly depending upon what ROM options the user has installed in the controller.

The read statement is always referenced to the format statement. Format z must be used to delete the CR/LF.

2.13 RESPONSE TIME

The total response time of the Model 76A with -01 option is made up of four parts:

a.	Command Time	0.2 milliseconds per character
b.	Measurement Time	125 milliseconds (500 ms if either 2 pF and/or 2 µS ranges are used)
c.	Data Formatting Time	10 milliseconds
d.	Data Transmitting Time	0.2 milliseconds per character

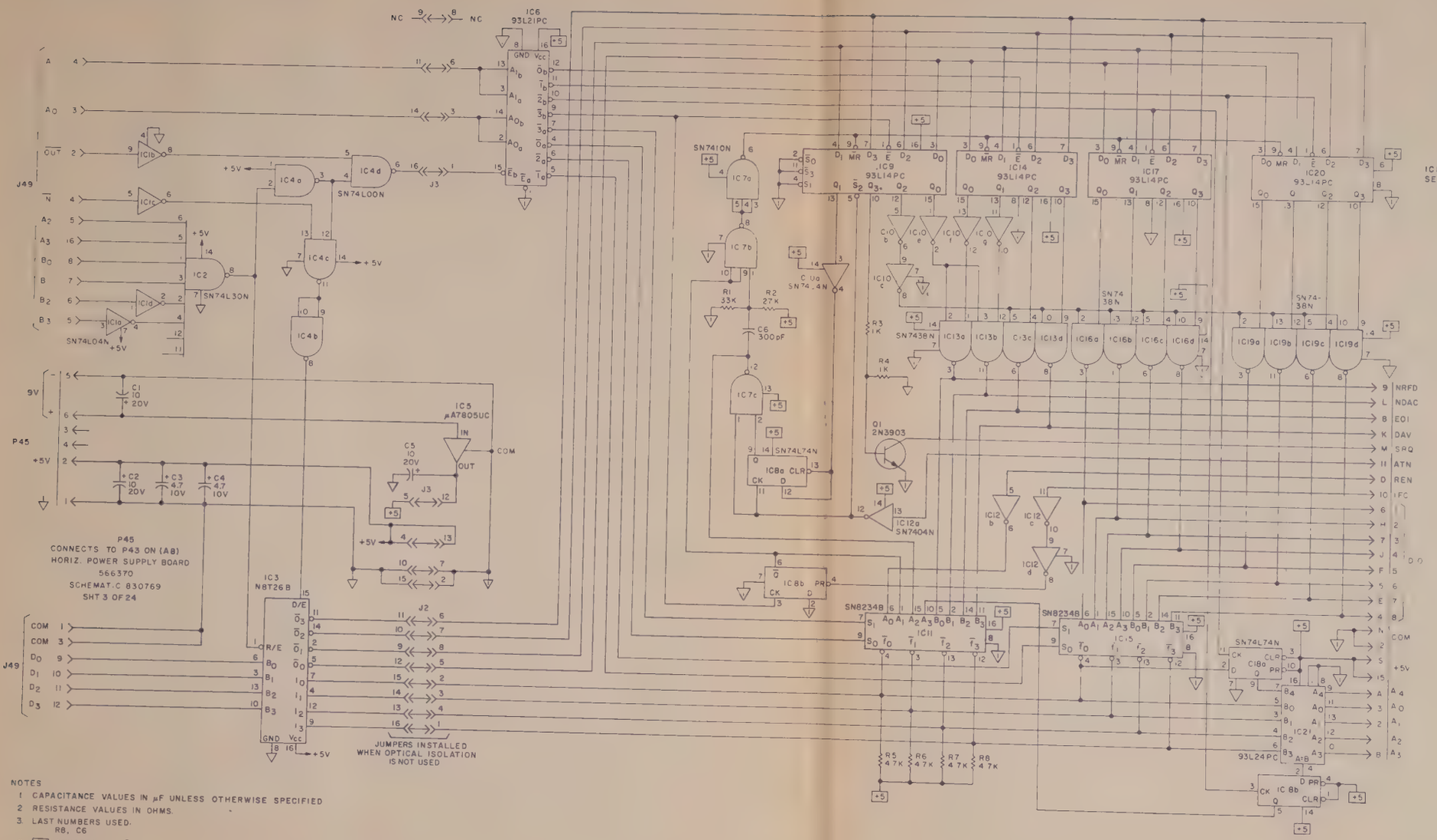
2.14 J51 CONNECTOR CONTACT ASSIGNMENTS

Contact	Signal Line	Contact	Signal Line
1	DIO 1	13	DIO 5
2	DIO 2	14	DIO 6
3	DIO 3	15	DIO 7
4	DIO 4	16	DIO 8
5	EOI	17	REN
6	DAV	18	Gnd, (6)
7	NRFD	19	Gnd, (7)
8	NDAC	20	Gnd, (8)
9	IFC	21	Gnd, (9)
10	SRQ	22	Gnd, (10)
11	ATN	23	Gnd, (11)
12	SHIELD	24	Gnd, LOGIC

NOTE: Gnd (n) refers to the signal ground return of the referenced contact.

6 5 4 3 2 1
C1
C2
J49
IC3
IC5
C3
IC1
IC4
J2
J3
IC2
IC6
R8
R5
R6
R7
R1
R2
C6
IC7
IC8
IC12
IC9
IC10
R3
IC14
Q1
IC11
IC13
R4
IC17
IC15
IC16
IC21
IC20
IC18
IC19
C5
C4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

A40 IEEE BUSS INTERFACE P.C. BOARD

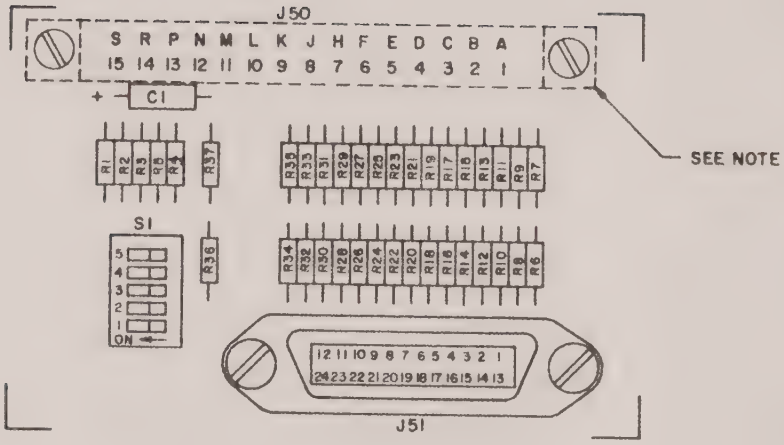


NOTES

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED: R8, C6
4. +5 DENOTES 5V; ▽ DENOTES GND } POWER SUPPLY CONNECTIONS (OPTIONALLY ISOLATED).
5. TYPICAL GND CONNECTIONS FOR IC14, 17, & 20.

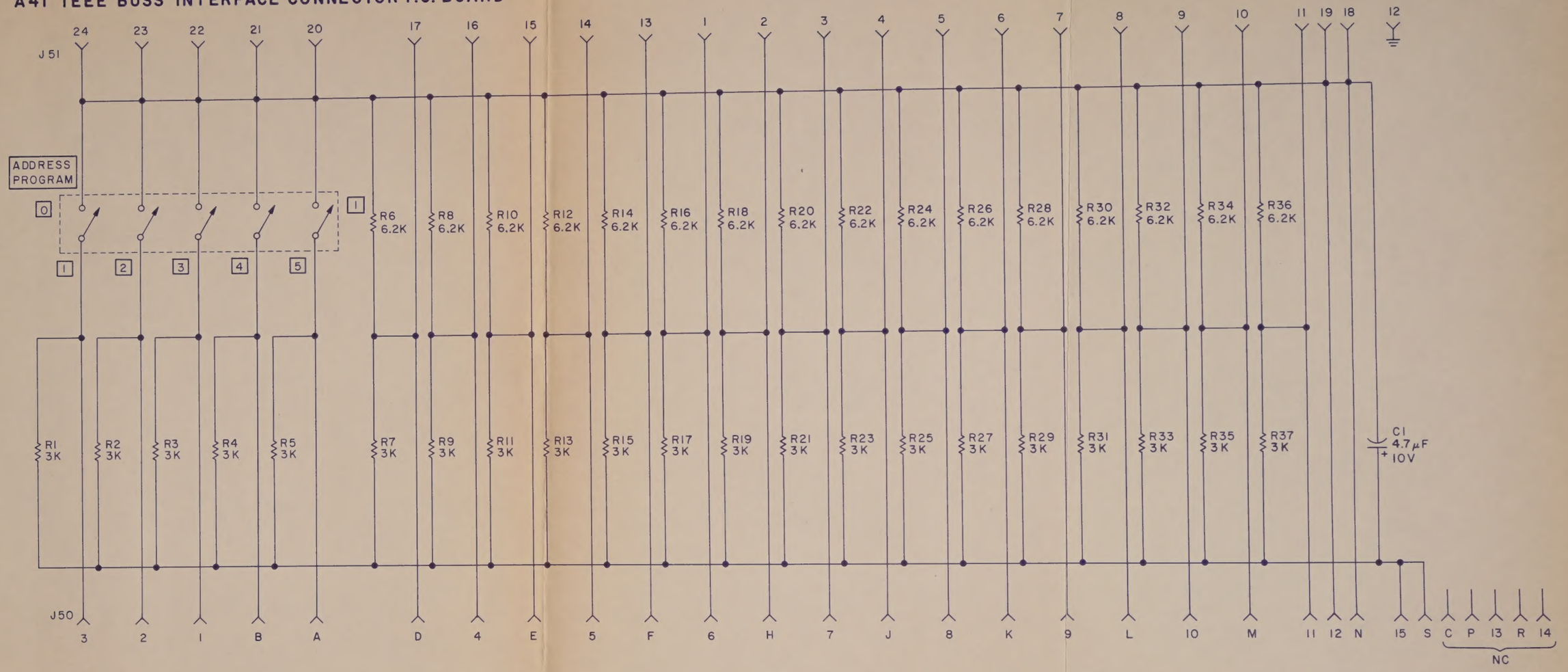
BOONTON ELECTRONICS CORPORATION

MODEL 76A-01
Schematic, IEEE Bus Interface PC Board
E830833, Sheet 1 (A40)



NOTE:
THIS CONNECTOR MOUNTED ON BOTTOM SIDE OF BOARD

A41 IEEE BUSS INTERFACE CONNECTOR P.C. BOARD



NOTES:

1. RESISTANCE VALUES IN OHMS.
2. [ ] EXTERNAL MARKINGS.
3. LAST NUMBERS USED:
   R37

BOONTON ELECTRONICS CORPORATION

MODEL 76A-01
Schematic, IEEE Bus
Interface Connector PCB
D830833C, Sheet 2 (A41)

ADDENDUM

MODEL 76A AND OPTIONS -01, -02, -04, -05

For ROM PC board assemblies containing 2716 EPROM's, the conditions of DIP switches located on the top left corner of the ROM PC board are as follows:

1. Switches #2 and #3 are not active (they are not connected), and are normally in the up position.

2. Switch #1 should be in the up position normally and is switched down if "Manual Step Programmer" Mode is required.

3. Switch #4 is active only if one of the Option EPROM's is installed, and is in the up position if Option -01 or -04 is required; it is in the down position if Option -02 or -05 is required.